COMP 308
ARTIFICIAL INTELLIGENCE
PART 8.1 – LEARNING

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Overview

- Introduction to machine learning
- Machine Learning Models
- Machine Learning Methods
- Machine Learning Paradigms

Learning & Adaptation

- Learning in general:

  "Modification of a behavioral tendency by expertise." (Webster 1984)

- Learning Machine:

  "A learning machine, broadly defined is any device whose actions are influenced by past experiences." (Nilsson 1965)

- Machine Learning: (how does a machine learn – slide 3)

  "Any change in a system that allows it to perform better the second time on repetition of the same task or on another task drawn from the same population." (Simon 1983)

  "An improvement in information processing ability that results from information processing activity." (Tanimoto 1990)

Machine Learning

- Machine learning involves automatic procedures that learn a task from a series of examples

- Most convenient source of examples is data

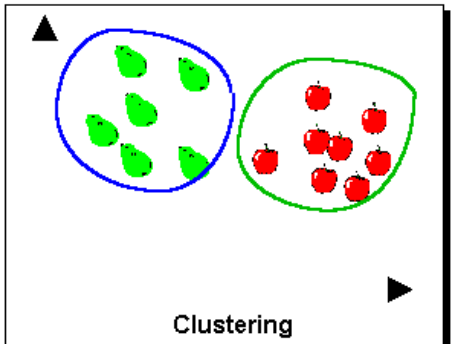
Learning

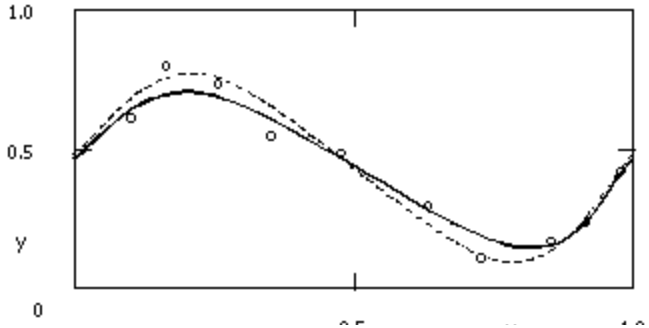
Definition:

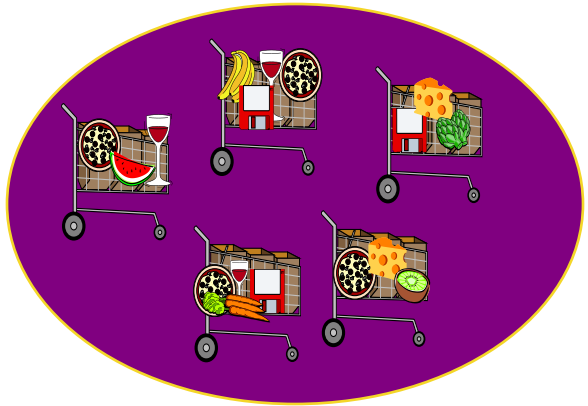
A computer program is said to **learn** from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience.

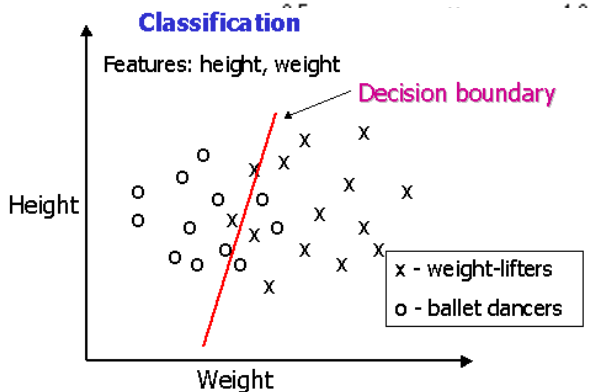
Machine Learning Models

- Classification
- Regression
- Clustering
- Time series analysis
- Association Analysis
- Sequence Discovery
- ….







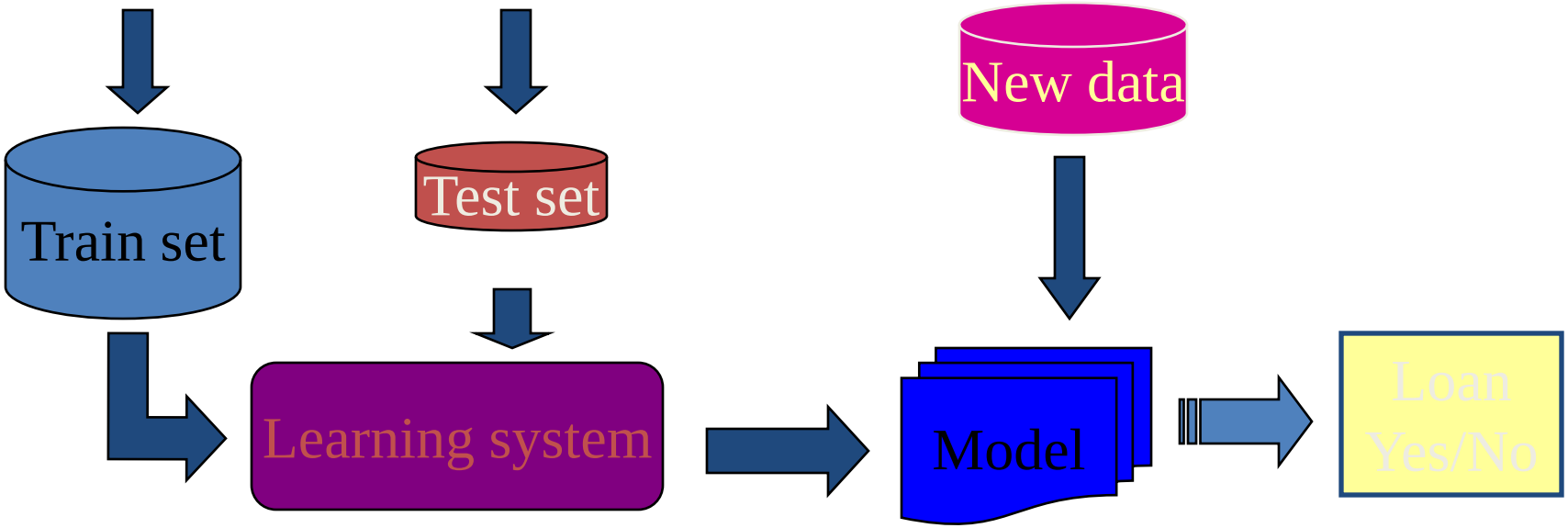


Classification example

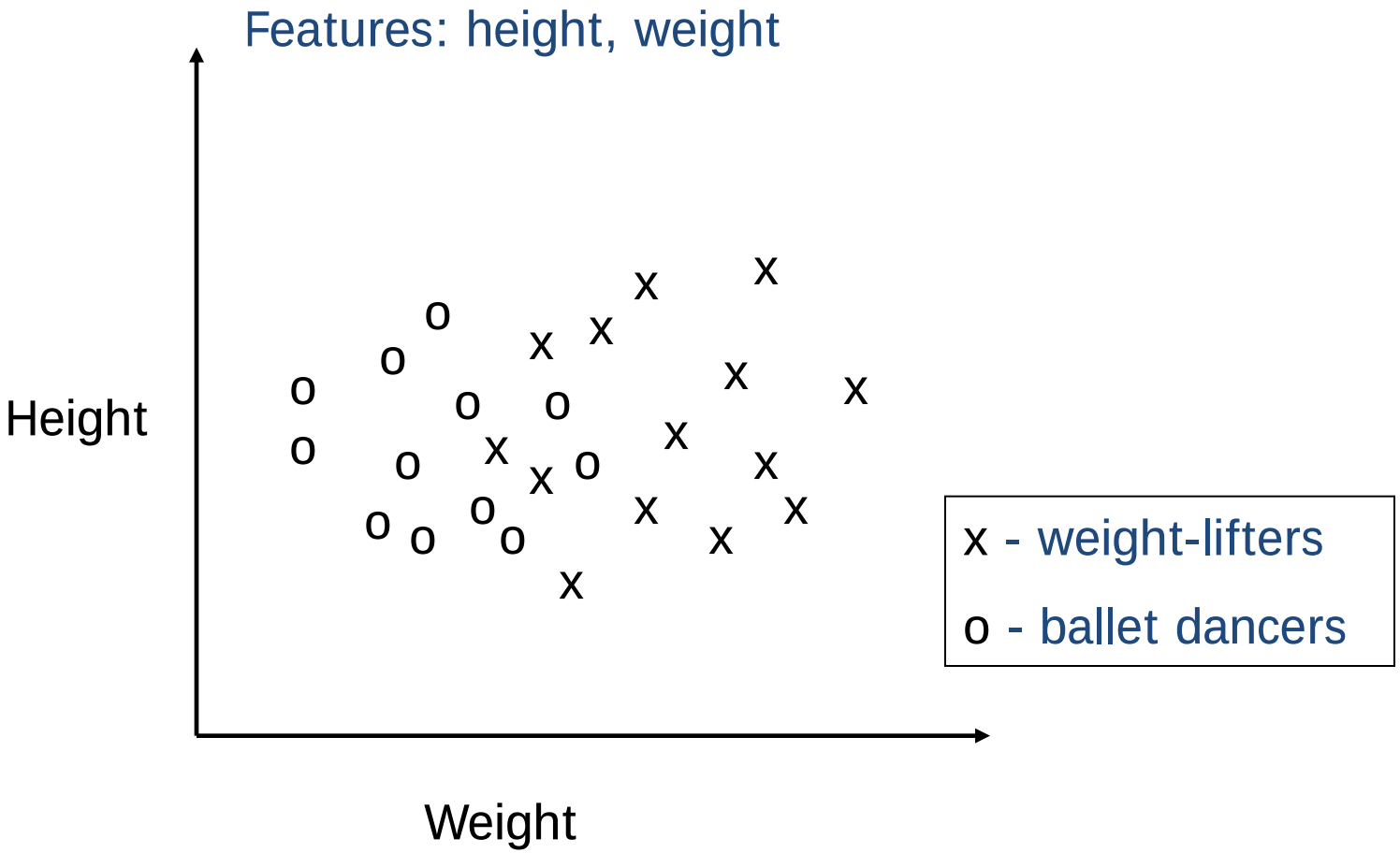
Loan Application Appraisal

No	Sex	Age	Marital status	Net Income	...	Loan
1	F	38	Married	45K	.	Yes
2	M	42	Married	66K	.	Yes
3	F	52	Single	43K	.	No
4	M	50	Single	70K	.	No
5	F	27	Married	40K	.	No
6	M	45	Divorced	38K	.	No
7	F	35	Widow	59K	.	Yes
8	M	32	Married	52K	.	Yes
..						

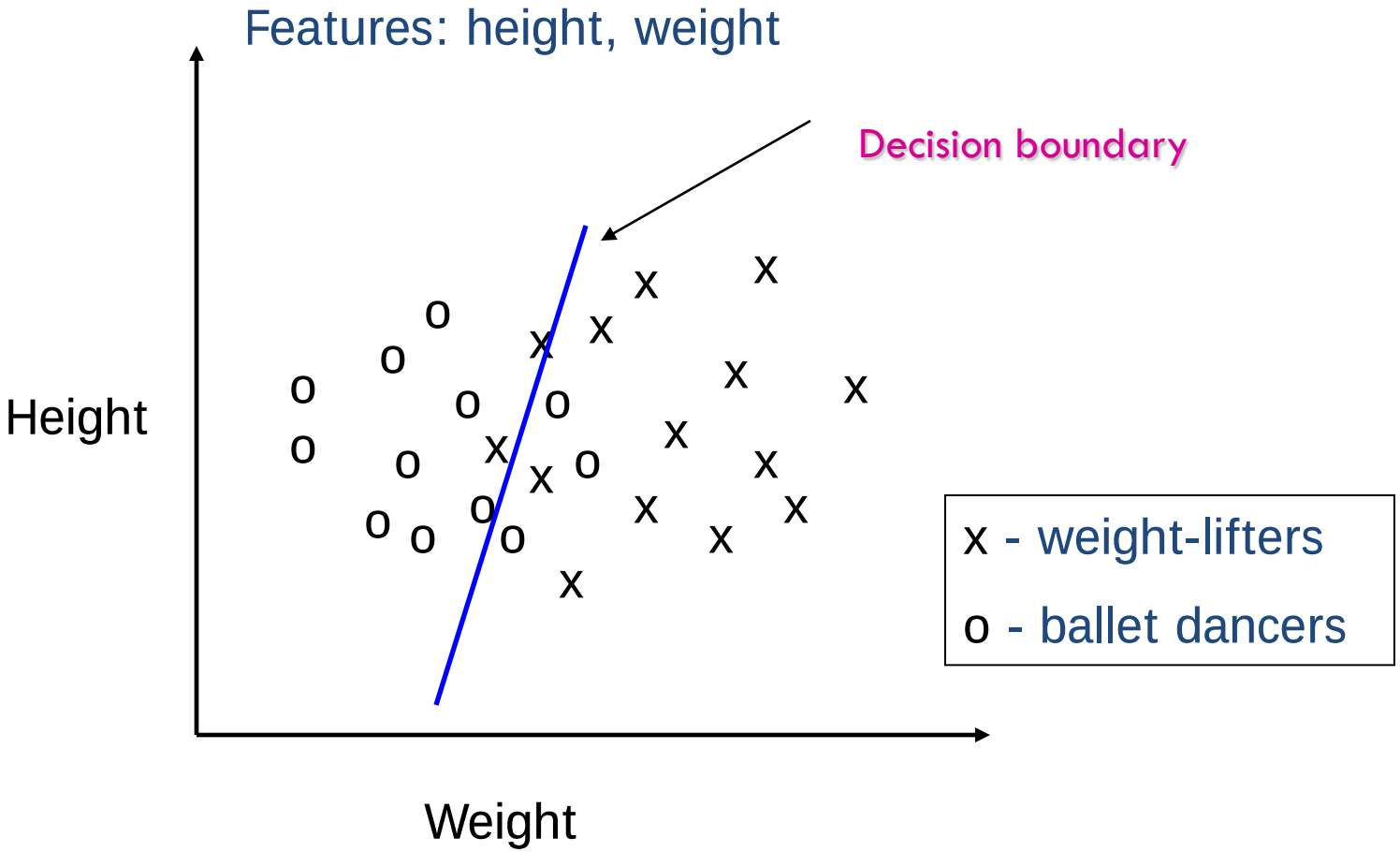
Sex	Age	Marital status	Net Income	...	Loan
F	28	Married	44K	.	?
M	47	Divorced	95K	.	?
F	30	Single	45K	.	?
M	55	Single	69K	.	?
M	45	Married	41K	.	?



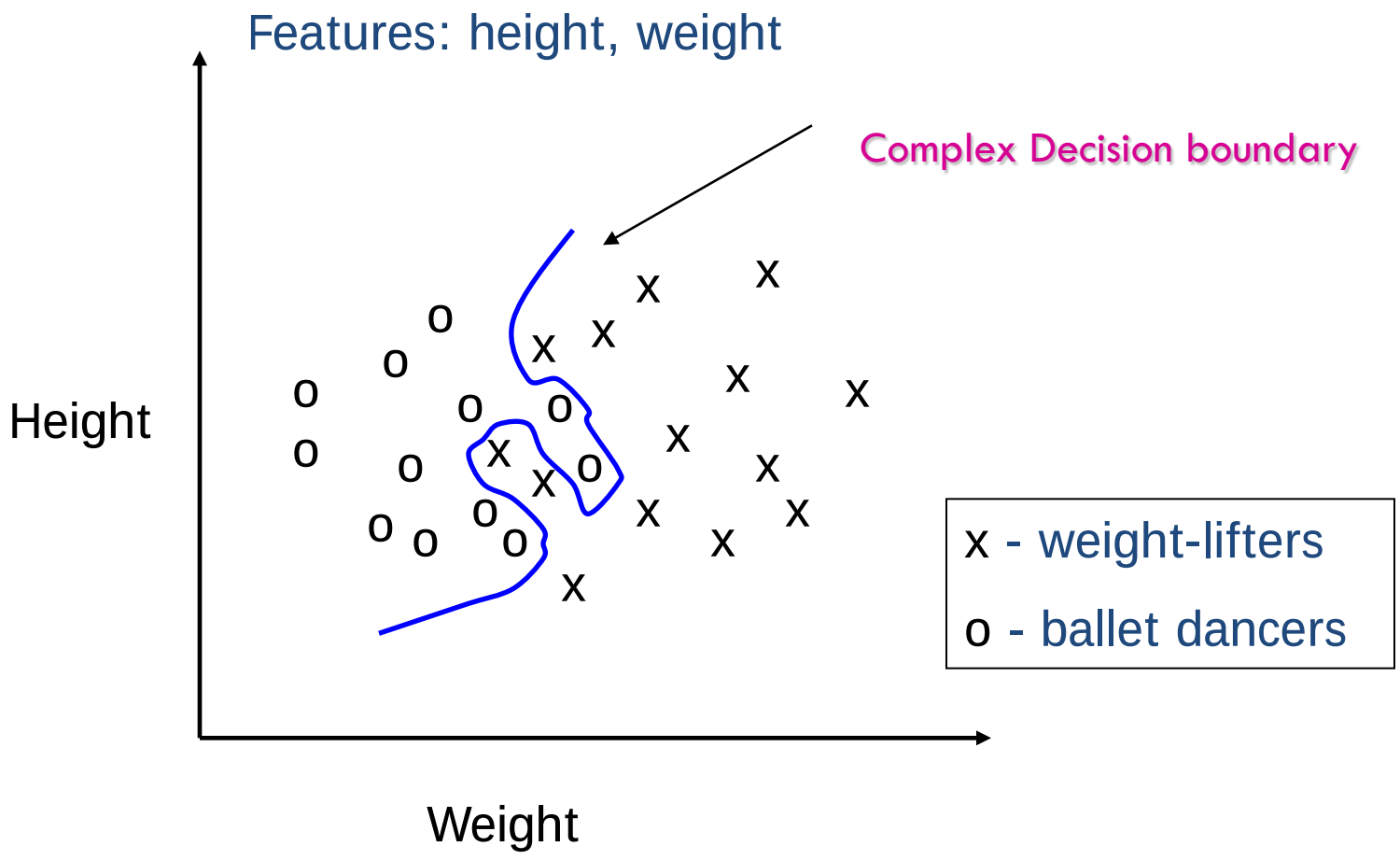
Classification example



Classification example - Simple Model



Classification example - Complex model



Note: A simple decision boundary is better than a complex one - It GENERALIZES better.

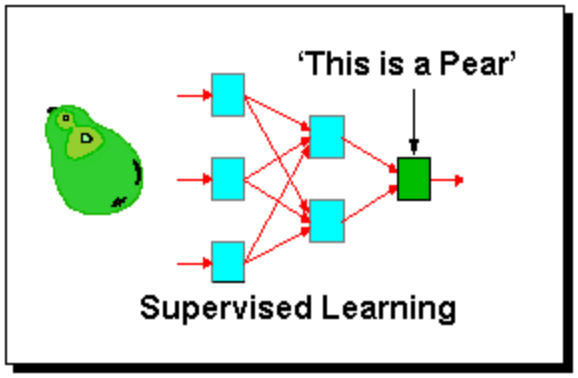
Machine Learning Methods

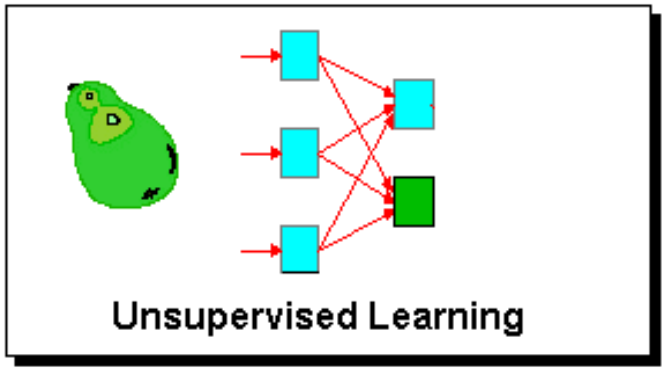
- Artificial Neural Networks
- Decision Trees
- Instance Based Methods (CBR, k-NN)
- Bayesian Networks
- Evolutionary Strategies
- Support Vector Machines
- ..

Learning Paradigms

The three main paradigms of machine learning are:

- Supervised learning - with teacher
  - inputs and correct outputs are provided by the teacher
- Reinforced learning - with reward or punishment
  - an action is evaluated
- Unsupervised learning - with no teacher
  - no hint about correct output is given





The Role of the teacher

- Supervised learning: the system uses a teacher
  - Concept Learning: teacher provides labeled data (pre-classified examples) to the system
  - Reinforcement learning: teacher provides an estimate of the quality of system's response to the data (e.g. positive/negative or scaled)
- Unsupervised learning: no teacher is available to the system
  - Clustering: partitioning or conceptual, flat or hierarchical
  - Finding regularities in data: Data Mining, Knowledge discovery

What does the system learn?

- Prediction: learning to predict values of unknown function
  - Classification: binary function
  - Regression: continuous-valued function
- Concept learning: the systems acquires descriptions of concepts
- Explanation-based learning: using traces (explanations) of correct (or incorrect) performances the system learns rules for more efficient performance of unseen tasks
- Case-based (exemplar-based) learning: the system memorizes cases (exemplars) of correctly classified data or correct performances and learns how to use them (e.g. by making analogies) to process unseen data

Reading assignment

- Why is learning hard?